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PRELIMINARY REPORT ON SOME PLANTS FROM THE CLEVELAND SHALE

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Abstract

This report gives for the first time descriptions of plants of the Cleveland Shale. Ten different specimens found as compressions or petrifactions in the shale are described. Six are assigned to the group Lycopsida, three are unassigned, and one is probably a progymnosperm. Surprisingly, of the six lycopsids, four are represented by large, well-preserved cones.

Introduction

The Cleveland Shale, of Upper Devonian Age (Banks and Feldmann 1970), outcrops mainly to the west and the southwest of Cleveland, Ohio. This marine shale is black to greyish black in color and is nicely exposed in Big Creek and on the banks of the Rocky River (Fig. 1).

The story of the shale goes back to 1866 when for the first time it caught the attention of Rev. H. Hertzer who first collected fossil fish from it. Hertzer found evidence of many large and strange creatures with heavily armored heads and jawbones that were in such abundance here and elsewhere that the Devonian has been called the "Age of Fishes" (Hyde 1926).

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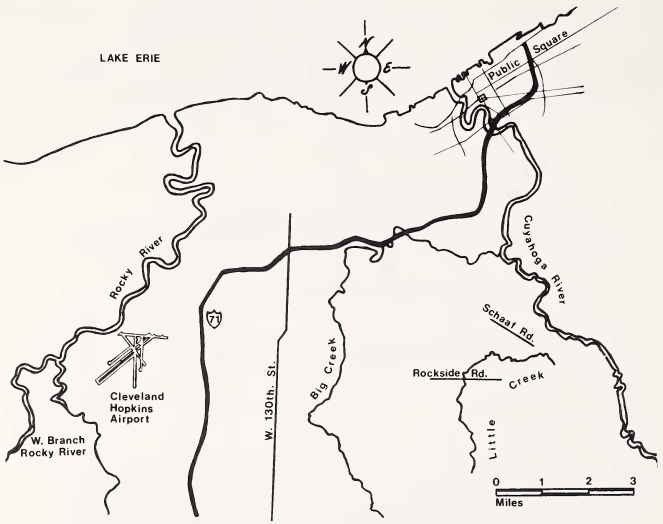


Fig. 1. A sketch map showing part of the Greater Cleveland area.

In the early 1880s, Dr. William Clark, Dr. D. T. Gould, and Prof. William Keppler, all of Berea, Ohio, made enormous collections, probably the finest of their kind. One of the collections went to the British Museum, while the second is said to be in the American Museum (Hyde 1928). Later, the elder Bungart and his son collected many specimens from near their home on the Vermilion River. This entire collection (probably the third best) is in the Cleveland Museum of Natural History.

Because the fossil fishes were large enough to attract the interest of the general public, they started receiving the attention in 1924 of many workers from the museum, including Hyde (1926, 1928, 1965), Newberry, Dunkle, Bungart, and others. The plant remains, however, were ignored. During the I-71 excavation project in 1965, many more fossil specimens from the Cleveland Shale were salvaged and added to the museum collection (Scheele 1965). They contain well preserved remains of both plants and fishes. The plants of

the Cleveland Shale from the Cleveland localities have not been previously studied and there is, to date, no publication on these plants. With this background, the research described herein has been undertaken to investigate the macrofossil remains of plants of the Cleveland Shale. A future study of the spores of the shale is anticipated.

This first, preliminary communication describes, in a general way, the plant remains from the museum collection currently being studied.

Material and Methods

The compression specimens sometimes consist of both part and counterpart. Many, however, are either part or counterpart. These are studied with hand lens and stereomicroscope in order to understand their morphology. A few of the specimens are permineralized. One of them was degaged from the matrix. In order to do this, the rock matrix around the specimen was softened by immersing it in 10 percent hydrofluoric acid for a few days; after washing it thoroughly in water, the softened rock was removed by scraping it out with a fine pointed probe under the low power of a stereomicroscope.

A piece of petrified wood was cut and etched with 40 percent hydrofluoric acid. After washing with water and allowing it to air dry, a thin layer of the organic cellular structure was embedded in a cellulose acetate film and removed as a section by the usual peel technique (Andrews 1961).

Description

The specimens studied for this report fall into three broad categories:

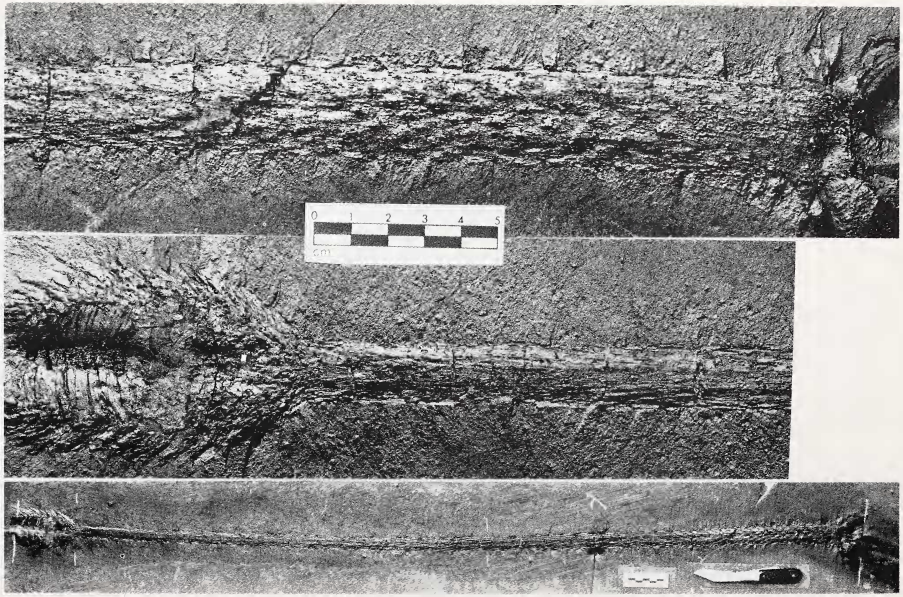
A. Lycopsida
B. Progymnospermopsida
C. Insertae Sedis

A. Lycopsida

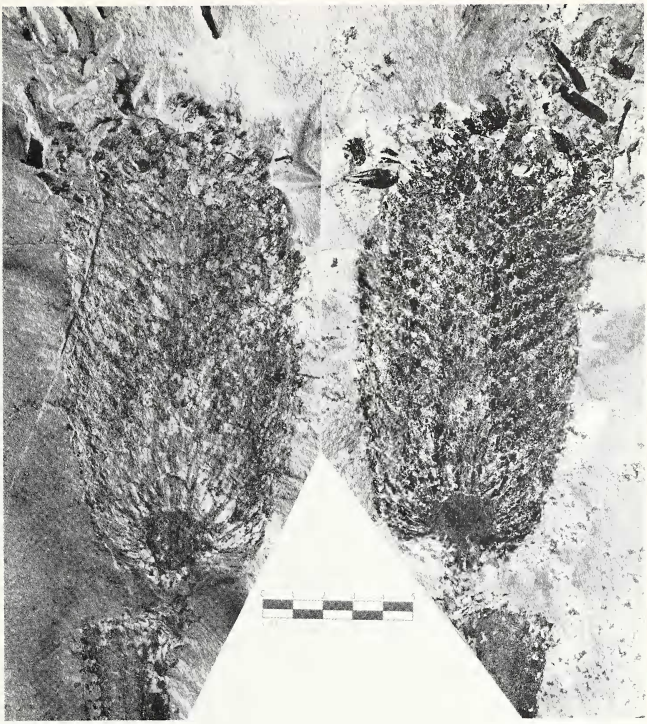
Six specimens are described under this group.

Specimen 1. CMNH No. 8137; Pl. I

This specimen, exposed as part and counterpart, was collected from the intersection of I-71 and West 130th Street in Cleveland when Interstate Route I-71 was being constructed. The specimen is a compression of a large branch measuring 3 ft 11 in. (119.5 cm) in total length including the

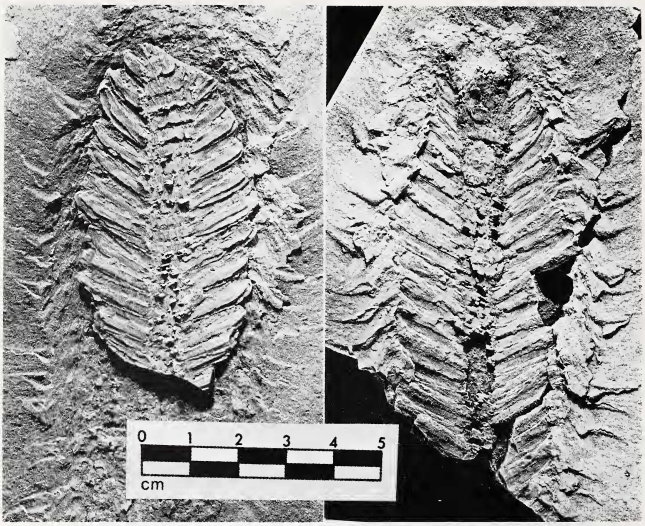


Pl. I. Bottom: a lycopsid specimen with cone at the apex; center: apical portion enlarged; top: basal portion enlarged.



Pl. II. Part (left) and counterpart of Specimen 2, a lycopsid cone.

3.5 in. of a globular conelike crown. The stem is unbranched and is 2.5 cm wide at the base, narrowing gradually to 1.5 cm at the attachment of the apical cone, which is 8.4 cm long and 6 cm wide in the middle portion, narrowing at both ends to about 3 cm. The central axis of the cone is 1.3 cm thick and bears many sporophylls in a tight, shallow helix, or in close whorls. Each sporophyll is 1.2 cm long and 0.2 cm wide and has a midvein. The branch bears elongated leaf base scars arranged alternately in vertical rows. There are thick transverse marks on the surface of this

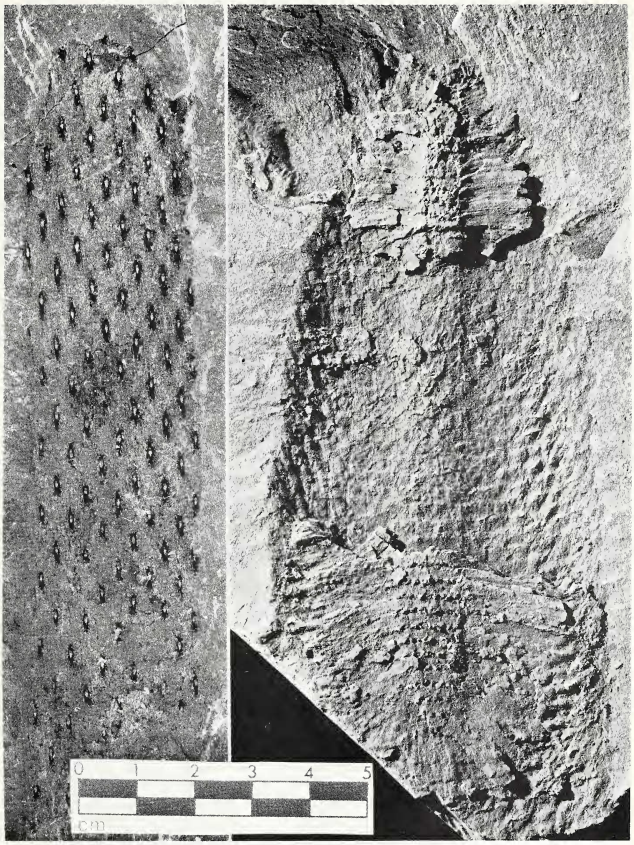


Pl. III. Part (left) and counterpart of Specimen 3, a lycopsid cone.

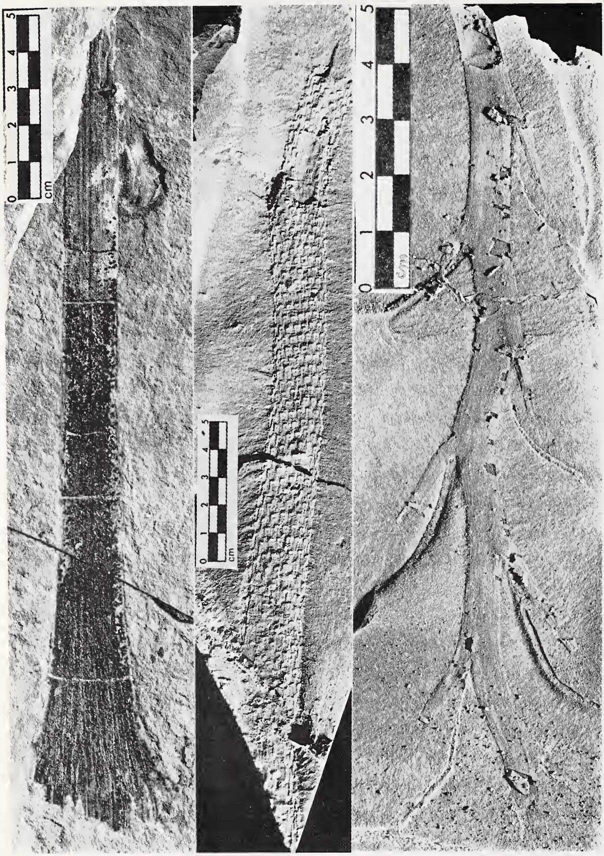
branch. The distance between the two adjoining marks is greater toward the base than toward the apex. The branch axis shows small spinelike structures on the two edges. These outgrowths, probably leaves, or leaf fragments, are about 1 cm long and 3 mm broad at the base narrowing to the tips.

Specimen 2. CMNH No. 8138; Pl. II

This compression of a large lycopsid cone is exposed on the shale in part and counterpart. This specimen is from the same locality as Specimen 1. The cone is 13.5 cm. long, and attached to a small piece of axis 5 cm long and 3 cm wide. The cone is 7.5 cm wide in the middle portion narrowing at both the ends to 5.5–5.8 cm, thus giving an elliptical shape to the whole cone. The central axis of the cone is 1.8 cm wide, bearing many sporophylls in a shallow helix or in close whorls. Each sporophyll is 1.8 cm long and 0.4 cm broad, lanceolate in shape with a single midvein.



Pl. IV. Specimen 4, right, a lycopsid cone; Specimen 5, a lycopsid axis showing leaf scars.



Pl. V. Specimen 6, center, an axis with *Cyclostigma*-like leaf scars: Specimen 9, bottom, a branched axis; Specimen 10, a leaf impression (?).

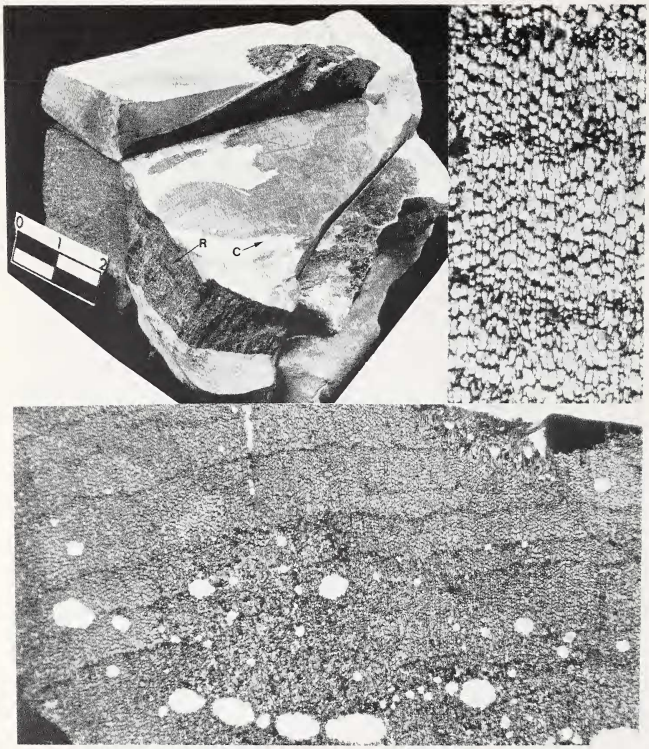
Specimen 3. CMNH No. 8972; Pl. III
This specimen, from the same locality as Specimen 1, is a compression of a lycopsid cone, 11.7 cm long and 4.5 cm broad, represented by both part and counterpart. This specimen was broken along a median longitudinal plane with approximately one-half of the cone represented on the part, the other half on the counterpart. Consequently, the cone axis is clearly exposed, and each sporophyll seems to bear a large sporangium on its upper surface. The central axis of the cone measures 0.6 to 1 cm wide. Each sporophyll/sporangium complex is strapshaped, 1.7 cm long and 0.3 cm broad.

Specimen 4. CMNH No. 8970; Pl. IV (right)
This specimen is yet another lycopsid cone, from the same locality as above. It is ovate in shape, 13 cm long and 5.3 cm wide at the lower end, narrowing at the top to 3 cm. The axis of the cone is 1 cm wide and the sporophylls are arranged in a shallow helix or in close whorls. During initial exposure of the specimen, it was broken in a way that shows, at either end, the cone axis bearing sporophyll/sporangium complexes, whereas the middle part of the specimen illustrates surface features of the cone in an impression. Each sporophyll/sporangium complex is 1.2 cm long and 0.2 cm wide.

Specimen 5. CMNH No. Nil; Pl. IV (left)
This compression of an axis 13.5 cm long and 2.8 cm broad shows elongated leaf cushions helically arranged and separated from each other by a distance of about 0.55 cm. Each leaf cushion measures 4 × 1 mm and has a leaf scar.

Specimen 6. CMNH No. 8143; Pl. V (center)
This compression of an axis is 27 cm long and 1.8 cm broad, showing close spirals of distinct leaf cushions. Each roundish cushion is of 1.7 cm diameter, with a flattened circular leaf scar. The specimen was collected from the I-71 locality.

B. Progymnospermopsida
Specimen 7. CMNH No. 7068; Pl. VI
The specimen was broken into pieces as shown in Pl. VI, top left. It is a piece of petrified axis, about 6 cm wide along the transverse surface and 2 cm long. This has been studied by taking peel sections from the transverse and longitudinal surfaces. Preliminary examination shows tracheids



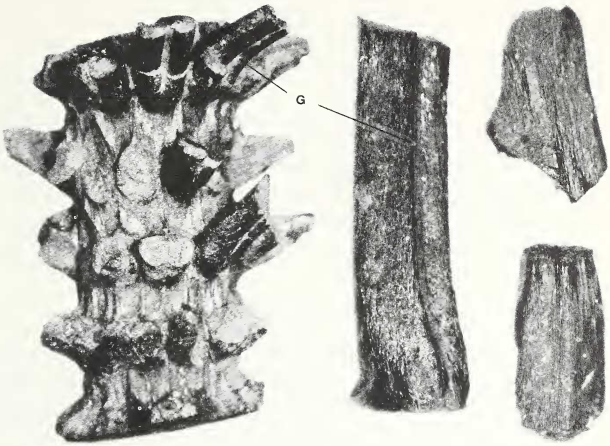
Pl. VI. Specimen 7, top left, a petrified piece of secondary wood. C: Cross; R: Radial longitudinal. Bottom: a cross section showing six growth rings magnified 15 times. Top right: a portion of the cross section enlarged 60 times.

in rows with narrow medullary rays and also distinct growth rings in the decorticated secondary wood. Primary wood and pith are absent.

C. Insertae Sedis

Specimen 8. CMNH No. Nil; Pl. VII

This specimen is a partially permineralized axis with appendage bases



Pl. VII. Left: a piece of degaged axis (Specimen 8) of undetermined taxonomic affinity showing appendage stalks in whorls, enlarged 15 times: G (grooves). Center: a broken-off appendage stalk, magnified 35 times. Right, top and bottom, pieces of appendage stalks magnified 35 times.

attached. A successful degaging exposed the tiny piece of an axis measuring 7 mm × 3 mm. The appendage bases, rather stout and cylindrical, are arranged in whorls around the axis. Distance between two successive whorls is 1 mm. Each appendage is grooved on the abaxial side, and is 1 mm thick at its base. These appendages are broken and their total length is unknown. The maximum preserved length is 3.5 mm. Attached to this axis fragment are five whorls, each of 12 appendage bases. Between each whorl the axis bears grooves and ridges (each ridge corresponding to an appendage base) that alternate in successive internodes.

Specimen 9. CMNH No. 8146; Pl. V (bottom)

This is a compression of a branched axis. The 0.2-cm thick branches are thinner than the main axis, which measures 0.7 cm thick and 14 cm long. The six branches are alternately arranged. The distance between two

successive branches is 1.8 cm. The branches taper to their tips and are spread in one plane. Each branch makes an angle of c. 20 degrees with the main axis. The surface of the axis and the branches is smooth. The specimen comes from the same locality as Specimen 1.

Specimen 10. CMNH No. 7135; Pl. V (top)
This broomlike impression contains a thin carbon film at some places. Total length is 21.3 cm and the width is 1.3 cm at one end, gradually flaring to 2 cm at the other. It is characterized by fine ribs. The distance between two adjoining ribs is 0.2 cm in the flared region and less than 0.1 cm in the lower region. There are also 6 crosswise ridges, possibly cracks, on the axis. The distal margin of the flared region has the irregular outline of the region of a large leaf from which a lamina had been torn.

Conclusion

Of the specimens thus far examined from the collection of the Cleveland Shale present in the Cleveland Museum of Natural History, six (Specimens 1-6) are lycopsids, three (Specimens 8, 9, 10) cannot be, as yet, identified with confidence, and one (Specimen 7) is probably a progymnosperm. Specimen 7 is secondary wood, possibly of *Callixylon,* but because the distinguishing character of radially banded grouped pits has not been yet observed, a positive identification cannot be made till it is studied in detail at a later date. *Callixylon* is the stem of a plant known as *Archaeopteris* (Beck 1960). The presence of *Callixylon* wood in the Cleveland Shale would be no surprise since the Cleveland Shale is part of the same black shale facies from which *Callixylon* has been discovered in abundance in Kentucky and Indiana (Hoskins and Cross 1951). *Callixylon* is often associated with *Archaeopteris* vegetative and fertile remains, but I have not yet found any *Archaeopteris* in our collection, unless Specimen 9 proves to be a branched rachis of an *Archaeopteris* "frond." The anatomy of *Archaeopteris* "fronds" (planated lateral branch systems) has been studied in detail by Carluccio, Hueber, and Banks (1966), and Beck (1971), and the anatomy of its stem by Berry (1932), Arnold (1929, 1930, 1931), Beck (1970, 1979), and others. From the Ohio black shale, well-preserved *Callixylon* has been investigated by Hoskins (1930), and Hoskins and Blickle (1940). The age of the locality at Beaver Pond, Adams County, Ohio is given by Hoskins and Blickle (1940) as Upper Devonian. However, Hoskins and Cross (1951), in their study of plants of the New Albany Shale, discussed the age of the Cleveland Shale

member and suggested that it is part of the Devonian-Mississippian transition zone.

Of the ten specimens described in this report, six are lycopsids, thus showing their abundance in the Cleveland Shale. These lycopsids largely resemble *Prolepidodendron, Protolepidodendron, Archaeosigillaria* (see Arnold 1939) and *Lepidodendropsis* (Read 1955). One specimen (6) resembles a *Cyclostigma.*

The presence of numerous, large lycopsid cones is an outstanding feature of the Cleveland Shale flora. Normally the vegetative parts of the lycopsids are more common than fructifications. The nature of particular lycopsid cones, whether homosporous or heterosporous, is yet to be determined. However, spores freed at random from the sporophyll/sporangium complexes of several different specimens and treated with Schulze's solution are of two sizes.

The well-defined growth rings in the progymnospermous secondary wood (Specimen 7) need to be mentioned. The development of growth rings suggests that the climate during this period might have been characterized by seasonal fluctuations. On the other hand, growth rings might also be explained as the result of regular fluctuations in moisture availability.

Specimen 8, although unidentifiable with confidence at this stage of the investigation, is especially interesting since it has some features (distinctly whorled appendages, grooved and ridged internodes) that suggest a possible sphenopsid affinity. The possibility that it is a lycopsid cannot be entirely ruled out, however, since sporophylls of lycopsid cones in very shallow helices may simulate a whorled condition, and the internodal ridges might be simply the decurrent bases of such sporophylls. Anatomical investigation of this specimen will probably solve the problem of its taxonomic affinity.

Specimen 10 is important because it adds to the taxonomic diversity of the flora. This specimen may be a fragment of a large *Psygmophyllum*-like leaf.

This preliminary report presents some highlights of the types of plants in the Cleveland Shale flora. Further extensive detailed study of every specimen will lead to their identification and will hopefully be useful in comprehending the nature of the flora and its stratigraphic placement—whether it falls in the Assemblage zone VI (*Archaeopteris* zone) or zone VII (*Rhacophyton* zone) (Banks 1980) or yet another zone of post-Famennian age.

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